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Clark.

Visual Imagery And Attention: An Analytical Study.

VISUAL IMAGERY AND ATTENTION: AN ANALYTICAL STUDY

BY

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A.B. Vassar College, 1913

THESIS

Submitted in Partial Fulfillment of the Requirements for the Degree of

DOCTOR OF PHILOSOPHY

IN PSYCHOLOGY

IN

THE GRADUATE SCHOOL

OF THE

UNIVERSITY OF ILLINOIS

1916

1916
C542

UNIVERSITY OF ILLINOIS

THE GRADUATE SCHOOL

17 Oct 16 GRAIS

May 11th 1916

I HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER MY SUPERVISION BY Helen Clark

ENTITLED Visual imagery and attention:an analytical study

BE ACCEPTED AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE DEGREE OF Doctor of Philosophy

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*Required for doctor's degree but not for master's.

342136

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CONTENTS

I. Introduction 1

II. Experimental: An Analysis of Visual Imagery..... 4

III. Experimental: Imagery, Ocular Movement, and Attention.....14

Experiment 1.....14
Experiment 2.....20
Experiment 3.....23
Experiment 4.....36

IV. Summary and Conclusions.....42

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CHAPTER I

Introduction

Since the appearance of Francis Galton's "Inquiries into Human Faculty and Its Development" in 1883, the question of imagery has received careful attention from psychologists and has presented an ever increasing diversity of problems. We shall not attempt an extensive review of the literature upon the subject, but shall mention briefly a few of the phases which are most closely connected with our present investigation. Considerable work has been done upon the genesis of imagery (i.e., its relation to perception). The experimentalists "incline to the view that there is no intrinsic difference between sensation and image."[1] Investigations in the field of suggestion reveal the fact that, under certain circumstances, simple or total-images may be mistaken for sensations or perceptions.[2] On the other hand, "a visual perception of distinctly supraliminal value may .....pass - even with specially trained observers - for an image."[3] Other investigations have dealt with the development or decay of images in the course of time. The associationists' conception of stable psychical entities has been discarded, and the

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[1] Perky, C.W., An experimental study of imagination, Amer.J.of Psychol., 1910, XXI, 435. Cf. Külpe, O., Phil.Stud., XIX, 508 ff., and Washburn, M.F., Mind, N.S. VIII, 1899, 32.

[2] Cf. Seashore, C.E., Measurements of illusions and hallucinations in normal life, Studies from the Yale Psychological Laboratory, 1893-97, I-V, 32.

[3] Perky, op.cit., p.435.

general view at present is that "the memory is not to be regarded as a storehouse of perfectly conserved images, but that the most simple memories are continually exposed to change, and that it is, at times, only by the combination of various memorial resources that retention is made definite and exact."[1] Experimental and theoretical inquiries have also been directed toward the general functions of the image in relation to thought and meaning,[2] discrimination and judgment,[3] and reproduction and recognition.[4] There have been some attempts at classification of total-images on a basis of divers characteristics (usually functional). Visual images have usually received the most attention. Four important investigations which have recently appeared are those of Perky,[5] Martin,[6] Koffka,[7] and Ogden.[8] Finally, images have been considered in their relations to motor phenomena, especially to ocular movement.[9]

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[1] Bentley, M., The memory image and its qualitative fidelity, Amer. J. of Psychol., 1899, XI, 47 f. Cf. Philippe, J., L'image mentale, (Evolution et dissolution)., Paris, 1903, 76 ff. and 116f.

[2] Cf. Betts, G.H., The distribution and functions of mental imagery, Teachers College, Columbia University, 1909, p.41.

[3] Cf. Whipple, G.M., An analytical study of the memory image and the process of judgment in the discrimination of clangs and tones, Amer. J. of Psychol., 1901, XII, 409 ff.

[4] Bentley, M., op. cit., 46.

[5] Op. cit.

[6] Die Projecktionsmethode und die Lokalisation visueller und anderer Vorstellungsbilder, Zsch. f. Psychol., 1912, LXI, 321.

[7] Zur Analyse der Vorstellungen und ihrer Gesetze, Leipzig, 1912.

[8] Experimental criteria for differentiating memory and imagination in projected visual images, Psychol. Rev., 1913, XX, 378.

[9] Perky, op. cit. and Ogden op. cit. Cf. Meakin, F., Mutual inhibition of memory images, Harvard Psychological Studies, I, 1903, 244; Moore, C.S., Control of the memory image, ibid., 296; Slaughter, J.W., Behavior of mental images, Amer. J. of Psychol., XIII, 1902, 548; Kuhlmann, F., Analysis of the memory consciousness, Psychol Rev., XIII, 1906, 338f; Murray, E., Peripheral and central factors in memory images, Amer. J. of Psychol., XVII, 1906, 241; Kulpe, Outlines, 1909, 187.

The problems and methods in Ogden's and in Perky's investigations closely resemble those of our own experiments. There are, however, three important differences. (1) Both Ogden and Perky discovered a number of intermediate or "equivocal" images[1] which did not seem to belong either among their "images of imagination" or with their "images of memory." We decided to include in our classification all non-verbal (or primary) images which were reported by our observers. (2) As regards ocular movement, Ogden obtained negative results,[2] while Perky, by means of another procedure, discovered a striking correspondence between the kind of image and the occurrence of ocular movements.[3] We decided to observe movements of the eyes by three different methods, one of them being somewhat similar to Perky's. (3) We proposed to discover, if possible, the factor or factors most closely connected with ocular movements, not simply the sort of image which usually involved such movements.[4]

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1 Ogden, op.cit., p.406. Perky, op.cit., 436.

2 Op.cit., p.381 f.

3 Op.cit., p.442 and 451.

4 Our observers, named in the order in which they served in the experiments were: an advanced undergraduate - Miss B.V.Copley (A); two graduate students - Mr.C.E.Holley (B), and Miss A.S. Rogers (C); three instructors in psychology - Dr.C.A.Ruckmich (D), Dr. J.E. DeCamp (E), and Dr. C. Rahn (F). The author wishes to express her grateful appreciation of their services and to acknowledge her especial indebtedness to Professor Bentley, under whose supervision the investigation was pursued.

CHAPTER II

Experimental: An Analysis of Visual Imagery.

1. Problem and method. Our first investigation was an analytical study of the visual images aroused by a series of words. The purpose of the experiment was to obtain a descriptive account of the images evoked with respect to twelve different characteristics, to classify the images with reference to two of these peculiarities, and to discover whether there was a resemblance in other details among the images of each group. There were two observers. A was an undergraduate who had done advanced work in psychology, and B was a graduate student who had had considerable practice in experimental observation. O was seated in a dark room facing a black wall. The experimenter took her place behind the observer at a table provided with a shaded light for the recording of O's descriptions. The experimenter transcribed O's account as he dictated it. For evoking the images, 114 substantives were used with A; with B, 75 words taken from the same list.[1] The instructions were as follows: "After a signal 'ready,' I shall pronounce a word. You are to note any visual images that may occur. As soon as they have disappeared, give a full description of them."

It is to be observed that the instructions were quite general. The subject was not required to call up an image, but merely to note any that should occur. Furthermore, the image was not supposed to be that of a particular object, but simply any visual image. The subject was not asked voluntarily to hold the image, which was to take its natural course.

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[1] Some of the words were: knife, river, dog, church, soap, cloud, grass, king, lyre, Cerberus, druid, tournament, King Arthur, wand, nightingale, baron, Marmion.

The description was not interrupted; but, when O had finished his account, he was questioned as to any points which he had overlooked. The experimenter sought complete information concerning (1) particularity, (2) familiarity, (3) the position of the image in relation to O, (4) the visual background, (5) the size of the image, (6) its stability, (7) the number and the degree of clearness of its details, (8) color, (9) accompanying affective tone, (10) somatic reference, (11) associative processes, and (12) temporal reference.

2. Results. The images reported were arbitrarily divided into three main groups. Those which referred to specified objects and which were apprehended as familiar were arbitrarily called F-images. Memory images, (those which not only referred to specified objects and were apprehended as familiar, but which also involved a reference to a specific time and place), were considered as a sub-class of the F-images. Images which were specific without being apprehended as familiar were called U-images. These were not necessarily accompanied by a feeling of strangeness; there was, in most cases, merely absence of familiarity. Finally, images of general reference, which involved no familiarity, were designated as G-images. In regard to position, the images were classified as usual when they had the same position in relation to the observer as the perceptual object usually occupied; they were called unusual if the position was not characteristic of the perceptual object, if the imaged object seemed detached from any setting, or if the localization was extremely indefinite. Images were classified as

unstable if they fluctuated, faded quickly, or were soon replaced by other images. When describing the details of images as many or few, the experimenter took into consideration the amount of detail which corresponding objects revealed in perception. Color was described as absent if color was normally present in the perceptual mode of the object. We took associative processes to mean relevant processes not completely assimilated to the total image. Such associative processes might occur at the same time as the principal image, although they were more apt to appear subsequently. Where the corresponding perception had occurred at some time within a year, the image was classed as recent. Somatic reference was present in several forms. In some cases, the observer simply was at the place presented in imaginal form.

"The church was in the position in which it would be if I were walking up to it." "Then the image changed as I went inside." "I was there. I seemed to be younger than I am now." "I was lying on my back and looking at the clouds."

Some images stood in definite relation to certain parts of the body.

"The gun was parallel to my arm as though my arm were extended." "The bird was back of myarm at the left. I thought of turning my head and looking at it." "The shoes were on my own feet."

In some cases, the somatic reference was more explicit.

"I imagined myself as there." "I seemed to be coming along the walk." "I knew that I was there."

In one case, the subject had a definite visual image of herself.

"I saw myself take the key out of the rubber where it is kept."

All of these functional distinctions are, of course, more or less crude. They should, however, suffice to reveal any striking dissimilarities existing among our classes.

Table I shows the distribution of the different kinds of images for each observer.

Table I.

	F-images	G-images		U-images	Totals
	Primary	Primary	Secondary	Primary	
Subject A	36	61		43	140
Subject B	36	12	7	4	59
Totals	72	73	7	47	199

Most of the visual images were primary (non-verbal), but some of B's images were secondary or symbolic (verbal). The 7 secondary visual images mentioned in the table occurred alone. They are not included in the following discussion of results unless specifically mentioned. In connection with B's primary images, 19 secondary images occurred. These were classed as associations.Of the total 26 secondary images, 18 were both visual and kinaesthetic in character, while 8 were purely visual.

Table II shows a more detailed analysis of the images.

As regards the temporal relations of the F-images, over half (53% and 61%) were referred to objects seen habitually and recently (within a year), while more than a third (36% and 39%) referred to objects perceived on some recent and specific occasion. In 11% of A's F-images there was recognition without definite temporal relations. Under three of the principal headings of classification there seemed to be little or no correspondence between the

TABLE II

			POSITION		BACKGROUND				SIZE			STABILITY		DETAILS AND CLEARNESS				COLOR		AFFECTIVE TONE			SOMATIC REF.		ASSOCIATIVE PROCESSES			TEMPORAL RELATIONS		
			USUAL	UNUSUAL	LACKING	COLOR-SHADE-HAZE	VAGUE SCENE	CLEAR SCENE	EXAGGERATED	NORMAL	DWARFED	STABLE	UNSTABLE	MANY-CLEAR	MANY-VAGUE	FEW-CLEAR	FEW-VAGUE	PRESENT	LACKING	PLEASANT	NEUTRAL	UNPLEASANT	PRESENT	LACKING	PRESENT	LACKING	ONLY IMAGE OF STIMULUS-WORD	RECENT-HABITUAL	RECENT-SPECIFIC	UNCERTAIN
F-IMAGES	A	No.	32	4	4	2	8	22	3	33		22	14	26	3	4	3	36		26	4	6	23	13	13	23		19	13	4
		%	89	11	11	6	22	61	8	92		61	39	72	8	11	8	100		72	11	17	64	36	36	64		53	36	11
	B	No.	35	7	3	2	20	11		35	1	14	22	11	5	7	13	33	3	17	19		22	14	13	13	10	22	14	
		%	97	3	8	6	56	31		97	3	39	61	31	14	19	36	92	8	47	53		61	39	36	36	28	61	39	
G-IMAGES	A	No.	37	24	12	28	17	4	10	46	5	29	32	19	1	23	18	60	1	27	20	14	7	54	9	52				
		%	61	39	20	46	28	7	16	75	8	48	52	31	2	38	29	98	2	44	33	23	11	89	15	85				
	B	No.	4	8	11		1			12		2	10		1		11	12			12		1	11	3	7	2			
		%	33	67	92		8			100		17	83		8		92	100			100		8	92	25	58	17			
U-IMAGES	A	No.	36	7	12	2	19	10	2	30	11	22	21	26	3	6	8	42	1	27	4	12	6	37	29	14				
		%	84	16	28	5	44	23	5	70	26	51	49	60	7	14	19	98	2	63	9	28	14	86	67	33				
	B	No.	3	1	2		1	1		4		2	2	1	2		1	3	1	1	3		2	2	2	2				
		%	75	25	50		25	25		100		50	50	25	50		25	75	25	25	75		50	50	50	50				

kind of imagery and a particular characteristic. These headings were color, stability, and size.

1. Color was present in all but six images. Three of these were F-images, one was a G-image, and one was a U-image.

2. Stability was characteristic of 61% of A's F-images, but 61% of B's F-images were unstable. Of B's G-images 83% were unstable. In the other cases, the percentages are not significant.

3. Normal size was reported in from 70% to 100% of the cases in each group. In the case of A, the G-images characterized by abnormal size were three times as numerous as the corresponding F-images, while the abnormal U-images were four times as numerous as the F-images. Of B's images, on the other hand, the F's were the only ones that were ever characterized by abnormal size. These reports, however, may be significant when considered in another connection. Table III showsthat it is usually the images of large objects that were under-sized and also those of small objects that were over-sized.

Table III

Images of	Exaggerated	Dwarfed
small objects	10	1
medium objects	2	
large objects	3	16

[1] J.M.Baldwin and W.J.Shaw (Memory for square size, Psychol.Rev., II, 1895,236) found that the size of comparatively small objects was over-estimated. H.K.Wolfe (Some judgments on the size of familiar objects, Amer.J. of Psychol., 1898,IX,137) discovered that familiar objects (e.g.,bank-notes)were under-estimated when drawn on paper. In criticism of this experiment it has been said that "this fact does not necessarily report the visual image of the note,since reproduction might easily be biased by the introduction of alien senses,i.e.,pressure,muscular exertion,etc."(M.Bentley,The memory image and its qualitative fidelity,Amer.J.of Psychol.,1899,Xi,1)

The small objects which were exaggerated when imaged were a picture of Queen Elizabeth, a pin, a lemon, a key, a cake of soap, a dinner-favor, a tomato, a maple leaf, and two flies. The image of a snake was under-estimated. The two medium-sized objects which were exaggerated in imagery were a coat and a bag. Of the large objects, a king, a giraffe, and Ceres were exaggerated, while a tower, a valley, a castle, a horse, a temple, a tabernacle, King Arthur, a crusader, a baron, a serf, Marmion, the Delphic oracle, the Nile, and three forest scenes were under-estimated when imaged. With 15 of the 17 images that were under-estimated there was a visual background. With 11 of the 15 that were over-estimated there was no visual background or only a shade or haze, while in 2 more cases the scene was vague.

Objects of a certain size are probably perceived with less effort than objects or scenes considerably larger or smaller. Perception of the small objects may involve unpleasant muscular strain resulting from the convergence of the eyes. This is especially true when the object is close to the observer. Large objects or scenes necessitate considerable ocular movement if all the different details are to be clearly perceived. In some cases, images seem to show a tendency to take that size which, in actual perception, would involve the least ocular strain.

Although the three kinds of images did not present marked differences as regards color, stability, and size, certain other peculiarities were more characteristic of one sort of image thanof another. We distinguish six cases.

1. The F-images usually occupied a usual <u>position</u> (89% and 97%); the U-images not quite so frequently (84% and 75%). A's G-images were less apt to occupy a usual position (61%), and, in the case of B, the position was even less likely to be usual (33%).

2. The <u>visual background</u> in 83% and 87% of the F-images and

in 67% and 50% of the U-images was a scene. On the other hand, there were scenic backgrounds in only 35% and 8% of the G-images.

3. The details of the images were both many and clear in 72% (A) and 31% (B) of the F's and in 60% (A) and 25%(B) of the U's. The details were few and vague in 29% (A) and 92% (B) of the G-images.

4. Somatic reference occurred with 64% and 61 % of the F-images and it was usually lacking in G-images (89% and 92%) and in U-images (86% and 50%).

5. Associative processes were not, as a rule, present with G-images (85% and 58%), were less often lacking in the case of F-images (64% and 36%), and were often present in U-images (67% and 50%).

6. As regards affective tone, F-images were often accompanied by pleasantness (72% and 47%), U-images were less frequently associated with pleasantness (63% and 25%), while with G-images consciousness was even less often pleasant (44% of A's images) and might be predominantly neutral in tone (100% of B's images). B reported no cases of unpleasant affective tone. Of A's 140 images, 32 were connected with unpleasantness. In 17 of these cases, however, the unpleasantness might be explained by the nature of the object imaged, while in 6 other cases the unpleasant tone was connected with associative connections. Only two images involved a definite feeling of strangeness or unfamiliarity. One of these was accompanied by pleasantness, the other by unpleasantness. These results would seem to show that imaging

in itself may often be pleasant, or that images referring to agreeable experiences are more apt to be recalled than are those referring to the disagreeable.[1]

A certain combination of characteristics might be regarded as peculiar to the pure type of each sort of image. The pure F-image may be distinguished by its usual position, its scenic background, many clear details, a pleasant affective tone, somatic reference, and associative processes. The pure G-image is in an unusual position and has no background, or merely a shade or haze as background, few and vague details, a neutral affective tone, no somatic reference, and no associative processes. Like the F-image, the pure U-image has a usual position, a scenic background, many clear details, a pleasant affective tone, and associative processes; but it has no somatic reference. If, however, one attempts

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[1] The belief that there is a tendency to forget the disagreeable is held by Colegrove (Memory, 1900, 11), Freud (Zur Psychopathologie des Alltagslebens, 1907), and Hollingworth (The oblivescence of the disagreeable, J. of Phil., Psychol. etc., 1910, VII, 709). This view is questioned by E.N.Henderson (Do we forget the disagreeable? ibid., 1911, VIII, 432), who found that one-third of the memories of ten observers were disagreeable. He considers it possible that the average person actually has more pleasant than disagreeable experiences, and that an incident which is remembered with pleasure might really have involved unpleasantness when it occurred. "We forget not so much disagreeable ideas as useless ideas"

TABLE IV

A's F-IMAGES

PURE TYPE	4											
				DETAILS			AFFECTIVE TONE					
VARIANTS IN ONE OR MORE CHARACTERISTICS			UNUSUAL POSITION	BACKGROUND LACKING OR HAZY	MANY-VAGUE	FEW-CLEAR	FEW-VAGUE	NEUTRAL	UNPLEASANT	SOMATIC REF. LACKING	NO ASSOCIATIVE PROCESSES
1	11	2		✓							
		1							✓		
		8									✓
2	14	1	✓	✓							
		2			✓						✓
		1			✓			✓			
		1				✓			✓		
		1					✓			✓	
		2							✓		✓
		6								✓	✓
3	4	1					✓	✓			✓
		2				✓				✓	✓
		1						✓		✓	✓
4	1										
5	1										
6	1										

B's F-IMAGES

PURE TYPE	1										
1	9	1				✓					
		3			✓						
		1					✓				
		3								✓	
		1									✓
2	19	1		✓		✓					
		1				✓		✓			
		1				✓				✓	
		2			✓			✓			
		8					✓	✓			
		1					✓				✓
		1						✓		✓	
		4								✓	✓
3	4	1		✓		✓		✓			
		1		✓		✓				✓	
		1		✓			✓	✓			
		1						✓		✓	✓
4	2						✓	✓			✓
6	1		✓	✓		✓		✓		✓	✓

TABLE V

A's G-IMAGES

PURE TYPE			1		DETAILS			AFFECTIVE TONE			
VARIANTS IN ONE OR MORE CHARACTERISTICS			NATURAL POSITION	SCENIC BACKGROUND	MANY CLEAR	MANY VAGUE	FEW CLEAR	PLEASANT	UNPLEASANT	SOMATIC REFERENCE	ASSOCIATIVE PROCESSES
1	13	2	✓								
		4			✓						
		2					✓				
		2							✓		
		3						✓			
2	16	2	✓						✓		
		1						✓			
		3					✓				
		1			✓				✓		
		7					✓	✓			
		1					✓✓		✓		
		1					✓				✓
3	15	1	✓	✓							
		1	✓	✓				✓			
		2	✓	✓					✓		
		1	✓	✓							✓
		1	✓	✓						✓	
		1	✓		✓			✓			
		1	✓		✓				✓		
		1	✓			✓		✓			
		4	✓				✓	✓			
		1		✓	✓					✓	
		1			✓			✓			✓
4	13	4	✓	✓	✓			✓			
		2	✓	✓			✓	✓			
		1	✓	✓			✓		✓		
		1	✓	✓			✓				✓
		1	✓	✓	✓					✓	
		1	✓	✓					✓	✓	
		1	✓	✓					✓		✓
		1	✓				✓	✓		✓	
		1	✓				✓		✓		✓
5	3	1	✓	✓	✓			✓		✓	
		1	✓	✓	✓			✓			✓
		1	✓	✓			✓			✓	✓

B's G-IMAGES

PURE TYPE			4 (The 7 Secondary Images also belong to this class)								
1	5	1	✓								
		1				✓					
		3									✓
2	3	1	✓							✓	
		2	✓								✓

TABLE VI

A's U-IMAGES

PURE TYPE	7				DETAILS			AFFECTIVE TONE			
VARIANTS IN ONE OR MORE CHARACTERISTICS.			UNNATURAL POSITION	BACKGROUND LACKING OR HAZY	MANY-VAGUE	FEW-CLEAR	FEW-VAGUE	NEUTRAL	UNPLEASANT	SOMATIC REFERENCE	NO ASSOCIATIVE PROCESSES
1.	10	2	✓								
		2		✓							
		1					✓				
		1							✓		
		4									✓
2	15	1	✓	✓							
		1	✓			✓					
		1		✓				✓			
		1		✓						✓	
		1		✓			✓				
		1				✓			✓		
		1			✓			✓			
		1			✓				✓		
		1					✓	✓			
		1					✓		✓		
		1						✓			✓
		1							✓	✓	
		3								✓	✓
3	10	1	✓	✓							
		1	✓			✓					
		1	✓				✓		✓		
		2		✓		✓			✓		
		2		✓			✓		✓		
		1		✓					✓		✓
		1		✓		✓					✓
		1			✓				✓		✓
4	1			✓	✓					✓	✓

B's U-IMAGES

PURE TYPE	0										
1	1									✓	✓
2	1				✓			✓			✓
3	2		✓	✓			✓	✓			

to classify the individual images under these detailed headings, it is evident that there are very few examples of the pure types and many deviations from them. Tables IV, V, and VI show these variations in detail.

Table VII summarizes the variations of the images from the pure types. The transition from one class to another was sometimes shown in other ways. In connection with one image there was a feeling of familiarity, but the subject was unable to place it in any spatial or temporal relations. In a few other cases there was no recognition; but scenes appeared as associations which the subject thought might possibly have been the original settings of the object. In four cases recognition occurred after the image had begun to fade. Several G-images and one U-image had as backgrounds scenes that were recognized. Once the image remained the same while one scenic background was replaced by another. In 44 cases the pronunciation of the word was followed by two successive total-images. Nine of these transitions were from one G-image to

Table VII

	A's images			B's images		
	F-images	G-images	U-images	F-images	G-images	U-images
Pure type	4	1	7	1	4	0
Variants in one or more characteristics: 1	11	13	10	9	5	
2	14	16	15	19	3	1
3	4	15	10	4		1
4	1	13	1	2		2
5	1	3				
6	1			1		

another of the same sort, nine were from an F-image to another F-image, and nine were from a G-image to a representation of the F class. In 13 cases, images from other sense departments were assimilated to the total-image. Five of these were temperature-tactual images, 5 were kinaesthetic-tactual, 2 were olfactory, and one was auditory.

So far as it is permissible to base general conclusions upon our material, these results seem to indicate that, although visual images may be classified according to their genesis or function, there are no definite groups which show peculiar patternings of the ten characteristics which we have mentioned. Individual differences are considerable, and intermediate images are very numerous. F-images, G-images, or U-images may, perhaps, best be considered as designating various points in a developmental series, rather than sharply differentiated classes.

CHAPTER III

Experimental: Imagery, Ocular Movement, and Attention.

Experiment 1

1. Problem and method. The purpose of this experiment was to discover whether there exists any connection between the general character and functions of the visual image and the occurrence and extent of ocular movements. A and B again served as observers. The subject was seated in the dark room with his head fixed in a headrest. A sheet of blank cardboard was placed at the distance of a meter from his eyes so that a white fixation point appeared opposite the fovea of the right eye. The experimenter, who was seated at the subject's right, observed the latter's eye through a hand lens. A black box with a very narrow slit in one side was so arranged that the light from an electric bulb inside produced a bright point of light upon the cornea. The position of the box was shifted until the point of light fell upon the iris of O's eye near the edge of the pupil. When the eye shifted, the margin of the pupil moved noticeably nearer to or farther away from the dot of light, which remained stationary. For the practice series, a sheet of black cardboard was used with a horizontal and a vertical line crossing at right angles. Distances of five cm. were laid off as units along each line. O looked at the fixation point, then at some point along one of the lines, then at the fixation point again. After practice, the experimenter was able to tell, with approximate accuracy, from the appearance of the eye, over how great a distance upon the cardboard the observer's glance had passed in a vertical or a horizontal direction. From the list used in the experiments of Chapter II, we selected the words which had aroused images differing but slightly from the

pure types. The selection was made so that the proportion of images in each of the three classes should be approximately the same. Sixty-nine words[1] were pronounced for A, while only the first 35 were used for B. The instructions are those of the preceding experiments with the following additions: "You are to fixate the white dot upon the black screen. When a visual image appears, try to keep it constant, but, if it disappears, do not make an effort to recall it. You are first to start the stopwatch when the image first appears, and to stop it when the image finally disappears." After the observer had given his account of the image, he was questioned as to any points which he had overlooked. The experimenter sought complete information concerning the visual background of the image, its size, and details, somatic reference, and accompanying kinaesthetic sensations.

2. Results. Table VIII gives a general tabulation of the images of observers A and B.

Some visual-verbal images occurred, but they are not included in these results. Reports are not included under every heading for every image, since in some cases the image would shift, or the subject would be uncertain as to an introspective item. The percentages are based upon the numbers tabulated.

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1. The list of words was as follows: sword, soap, ogre, leaf, ghost, orange, nymph, broom, pin, oracle, cat, tomato, druid, pipe, catacombs, horse, key, hamlet, convent, church, Marmion, lyre, snake, banana, ice, centaur, aeroplane, mirror, child, knife, serf, dungeon, stone, gun, tournament, boat, cloak, river, wagon, nail, tiger, helmet, coin, witch, moat, grave, wand, rose, dog, coat, cloud, ring, lion, grass, lemon, sled, hand, bag, chimney, purse, griffon, temple, shoe, Holy Grail, vase, Jupiter, sultan, shrine, Nile.

TABLE VIII

		TOTAL NO. OF IMAGES	VISUAL BACKGROUND				SIZE			DETAILS				SOMATIC REF.		KINAESTHETIC SENSATIONS OR IMAGES				OCULAR MOVEMENTS		
			BLACK SCREEN ONLY	LACKING	COLOR-SHADE-HAZE	SCENE	EXAGGERATED	NORMAL	UNDER-SIZED	MANY-CLEAR	MANY-VAGUE	FEW-CLEAR	FEW-VAGUE	PRESENT	LACKING	LACKING	OCULAR STRAIN	OTHER SENSATIONS	IMAGES (KIN.)	LACKING	PRESENT	
F-IMAGES	No.	45	0	1	0	44	0	44	1	34	0	4	2	36	7	32	7	1	4	25	20	
	%			2		98		98	2	85		10	5	84	16	73	16	2	9	56	44	
G-IMAGES	No.	33	14	10	8	1	0	30	3	13	2	4	12	0	31	25	3	0	0	32	1	
	%		42	30	24	3		91	9	42	6	13	39		100	89	11			97	3	
U-IMAGES	No.	18	5	0	0	13	1	11	6	8	4	1	5	0	15	11	4	0	0	6	12	
	%		28			72	6	61	33	44	22	5	28		100	73	27			33	66	
TOTAL		96																				

As regards the nature of the different sorts of image, these results are, on the whole, in accord with those of the experiments already recorded. F-images and U-images generally had a scenic background, while, with G-images, an imaged visual background was either only a haze or was altogether lacking. In F-images the details were usually numerous and clear. This was less often the case with U-images. G-images were more apt to have few and vague details than were those of either of the other groups. Somatic reference was characteristic of F-images, while it did not seem to be present with the other kinds. In this experiment, U-images seemed the most likely to be exaggerated or dwarfed. This was less often the case with G-images, and it seldom occurred with F-images. Ocular movements and sensations of ocular strain seldom occurred in connection with G-images, but were frequently noticed with the other varieties. Table IX shows the number and the extent of ocular movements. Although these movements were more

TABLE IX

	Average number of movements per image	Average extent of movement (in cm.)	Right to left		Left to Right		Up or down	
			Total no.	Extent cm	Total no.	Extent	Total no.	Extent
F-images	1.84	5.64	15	4.66	13	7.11	8	3.75
U-images	1.33	5.15	6	3.33	9	6.44	1	2.5

frequently present with U-images than with F-images, the average number of movements per image was less and the extent was less in the former case than in the latter. "Extent" refers to the distance on the cardboard screen over which the glance of the observer passed, not to the amount of movement of the eye-ball. Complete date concerning the duration of the images cannot be given; since 18 of the 33 G-images were immediately followed by F-images. In such cases, the duration of each could not be accurately determined. In 52 instances, however, the time-interval could be ascertained. These results are shown in Table X. F-images and U-images were appreciably longer than G-images. The significance of these figures is doubtful, however, because of

TABLE X

	Number	Average duration	M. V.
F-images	23	24.0 sec.	13.6 sec.
G-images	15	10.8 sec.	8.1 sec.
U-images	14	26.8 sec.	12.0 sec.

the large mean variation.

The fact that F-images and U-images are longer than G-images might account in some measure for the occurrence of ocular movements with the two former classes and their absence in other cases. The eyes might tend to move because there was long fixation, regardless of the nature of the accompanying image. The time-interval could not, however, be the sole factor involved, for ocular movements occurred with some very short F- and U-images, and did

not occur with G-images which were considerably longer. Ocular movements occurred toward the end of six images which lasted longer than 15 sec., but in 3 cases other movements had also occurred toward the beginning of the period.

The results of this experiment seem to indicate that there is some relation which obtains between ocular movement and different sorts of image. The existence of such a relation may seem strange in view of the results of our earlier experiment, which showed that when grouped according to characteristics, there are few images of any pure type, each class tending to merge into the others. But the correspondence may be due to the fact that the amount of ocular movement accompanying any visual image is related to its function, rather than to a definite patterning of characteristics, which, as we have seen, varies considerably within the groups. It is possible that different characteristic motor attitudes or general conditions of the organism occur with F-images, G-images, and U-images, and that these attitudes involve certain reactions of the ocular muscles. The fact that kinaesthetic sensations or images were reported in a comparatively small number of cases would not necessarily invalidate such a conclusion. The attention of the observer was directed toward the visual image, and the effects of muscular strain or movement might easily have been overlooked. The experimenter purposely refrained from all unnecessary emphasis upon this aspect of the problem in order that conditions might be as natural as possible.

To Page 20.

Experiment 2

1. Problem and apparatus. It occurred to the writer that the results of Experiment 1 would be more significant if confirmed by investigations involving an objective record of ocular movements. It also seemed advisable to try to find the particular factor or factors which were most closely connected with ocular movement, instead of resting content with the discovery of the association of such movement with certain kinds of imagery. These were our chief purposes in the present experiment. For recording ocular movement, we employed the writing tambour of the laryngeal recorder described by Krueger and Wirth[1] which was connected by rubber tubing to the nystagmograph of A. Schackwitz.[2] A record of the time in seconds was kept by means of an electric marker actuated by a metronome, or, in the later experiments, by a time-clock. A second pneumatic system was used to record the course of the image. A rubber bulb was fitted into a cardboard frame so that O could produce variations in the recording line by changing the degree of pressure upon the bulb.

2. Method. C, D, and E served as observers. E was assistant in psychology and had had considerable experience in experimentation. The observer was seated with his eyes closed and his head fixed in a headrest. The first pneumatic system was in-

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1 Psychol. Stud., 1905-06, I, 103.

2 Zsch. f. Psychol., 1913, LXIII, 442. The spectacles to which the tambour was attached proved to be unsatisfactory, so we detached the tambour and fastened it to a support made of a system of adjustable rods and attached to the headrest.

flated, and the small tambour (which was fastened to the headrest by an adjustable attachment) was placed against the lid of his right eye. Figure 1 shows the position of the observer and the apparatus. Figures 2 and 3 show the arrangement of the three re-

Fig. 1

cording points. The point at the right in each figure recorded the time in seconds, the one in the middle registered ocular movements, and the point at the left indicated fluctuations in the clearness of the image.

Fig. 2

Fig. 3

In a series of preliminary experiments it had been found that a change in the position of O's eye produced a perceptible fluctuation in the record made upon the smoked paper of the kymographic

drum. The instructions were as follows: "After a signal 'ready' a word will be pronounced.[1] If any visual image appears, try to hold it constant, but do not recall it when it disappears. With the right hand, compress the bulb when the image appears, increase the pressure whenever the image grows clearer and diminish the pressure whenever the image becomes less clear. After the image has disappeared, you will be interrogated as to (1) shifts in attention, (2) changes in the clearness, the intensity, and the content of the image, (3) associative processes, (4) somatic reference, (5) the visual background of the image, (6) specificity of the imaged object and its temporal and spatial relations, and (7) familiarity of the image." Sixty-three words were used with each of the three observers.

3. Results. Nothing of importance resulted from this experiment in respect to the characteristics of the different sorts of images. The descriptions are in general accord with the more detailed accounts discussed at length in Chapter II. The results are signiiicant, however, in that they show an appreciable correspondence between fluctuations in the clearness of the images and ocular movements. The records were divided into 5 classes according to the degree of correspondence. We described a record as showing no correspondence when one line fluctuated and the other did not, or when there were striking differences in the number

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[1] Some of the words were as follows: pickle, wizard, maypole, shell, moat, Hercules, shepherd, thimble, rainbow, scythe, commencement, dell, note-book, Scotchman, Cinderella, mouse.

and the position of fluctuations. Figure 4 shows typical examples of the records in which there was correspondence. Records 1, 2, and 3 are samples of perfect correspondence, record 4 of close correspondence, while in 5 the resemblance of the lines is general, and in record 6 the correspondence is limited. Table XI shows the classification of the results for each observer.

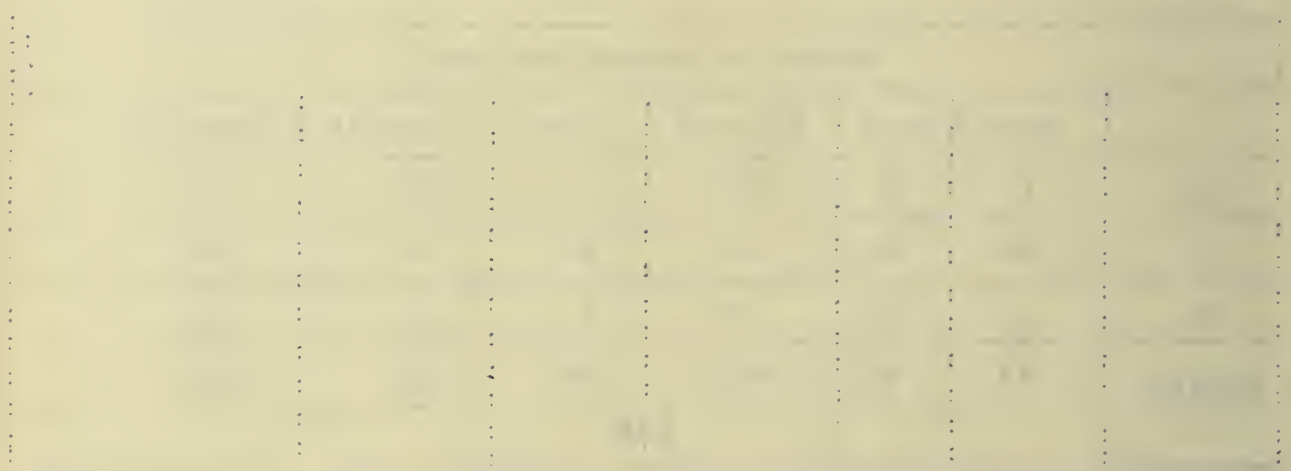
Table XI

	Amount of correspondence					
	None	Some	General	Close	Perfect	Totals
C	17	8	24	6	10	65
D	17	21	9	5	8	60
E	10	19	7	7	4	47
Totals	44	48	40	18	22	172
			128			

In 128 of the 172 cases, there appeared, then, a correspondence between the records for fluctuations of the clearness of the image and the records for ocular movements. This agreement is the more striking in view of the fact that very slight variations in the adjustment of the apparatus or in the time of O's response in varying the pressure upon the recording bulb might have changed the records in such a way that a correspondence which really existed would not be recorded.

Experiment 3

1. Problem and apparatus. In all of the preceding investigations, the images evoked differed widely in their nature



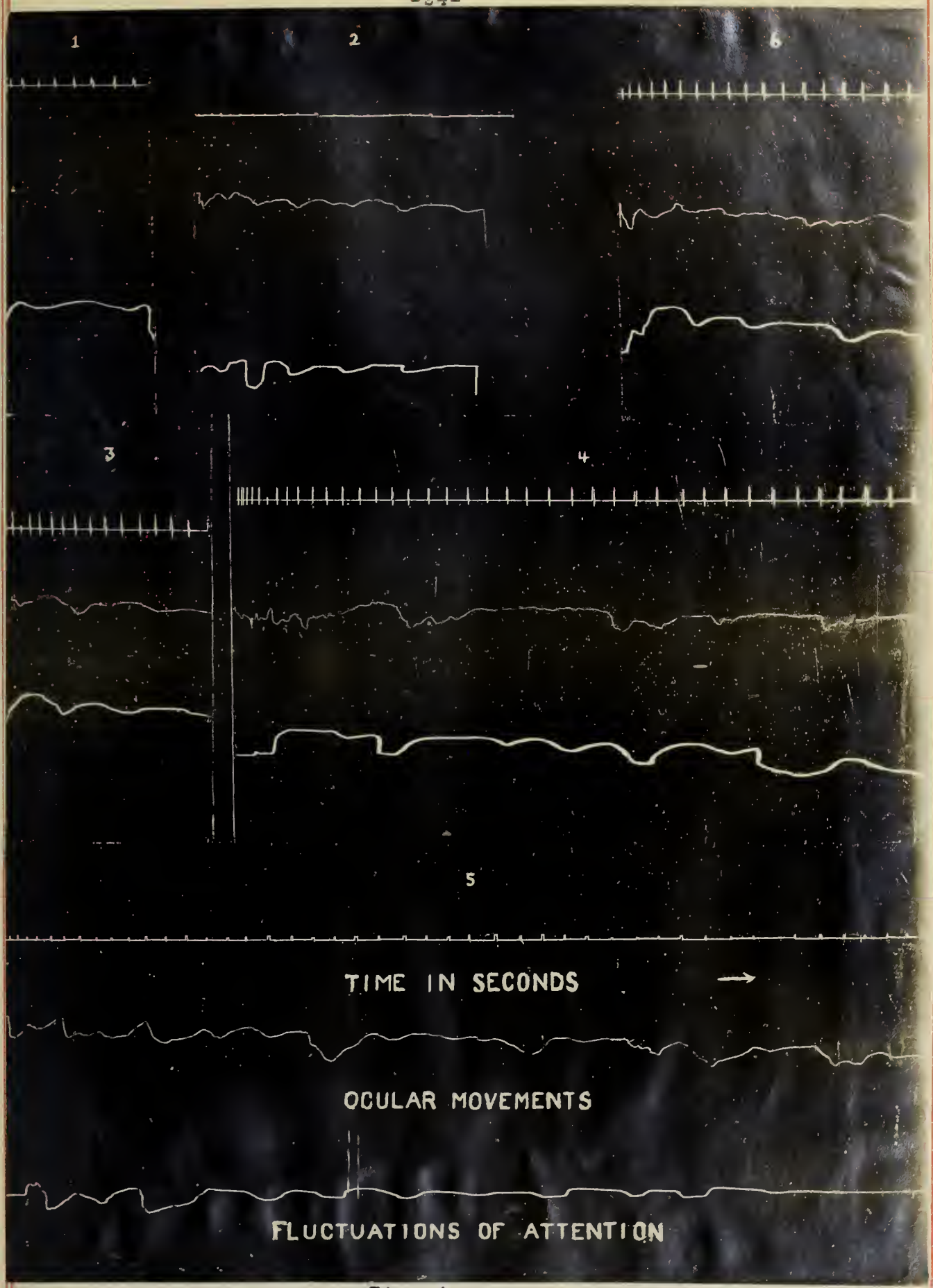

1
2
6
3
4
5
TIME IN SECONDS
OCULAR MOVEMENTS
FLUCTUATIONS OF ATTENTION

Fig. 4

and in their origin. Some were very schematic, while others presented many specific details. A considerable number referred to recent experiences, but some were related to habitual perceptions, and still others symbolized classes of objects. In view of these facts, it seemed advisable to investigate the occurrence of ocular movement in connection with images resulting from similar perceptions. We decided to employ a series of objects which were homogeneous except in respect to meaning, and to note whatever differences in ocular movement might occur when the objects were imaged. For this purpose, we devised the drawings reproduced in Figure 5. Each diagram was cut from white paper and pasted on a black card 5 inches square. Half of the pictures represented

Fig. 5
Drawings used in the perception-series[1]
(dimensions reduced $\frac{1}{2}$)

[1] The first, third, and fifth vertical rows contain "meaningless," the second, fourth, and sixth, meaningful or significant diagrams. The following names were given to the figures, reading from left to right: wij, bottle, ked, butterfly, fak, turtle, ged, star, pam, spool, tis, daisy, rel, key, bam, fish, hof, ring, lat, apple, zum, leaf, doj, cup, mej, knife, dak, pipe, kif, scissors.

meaningful objects, while the others were intended to be meaningless.

Ocular movements were detected by a method different from the methods used in our previous investigations. In Experiment 1, changes in the position of the eye had been observed by the experimenter; in Experiment 2, a mechanical device had been employed. In the following series, the observer himself reported the occurrence of ocular movement. Our plan was to place before the observer a circle of points of light arranged in such a way that, when fixation was steady, all of the lights would fall upon the blind-spot. A slight movement of the eye, however, would bring some of the bright points within the field of vision.[1] The apparatus (reproduced in Figures 6 and 7) consisted of two black metal boxes designed for the investigation of indirect vision. The large disc, A, could be rotated so that its radii fell upon any of the 360 degrees. For this experiment, however, the position of A was not changed. All of the discs, B and C, could be rotated so

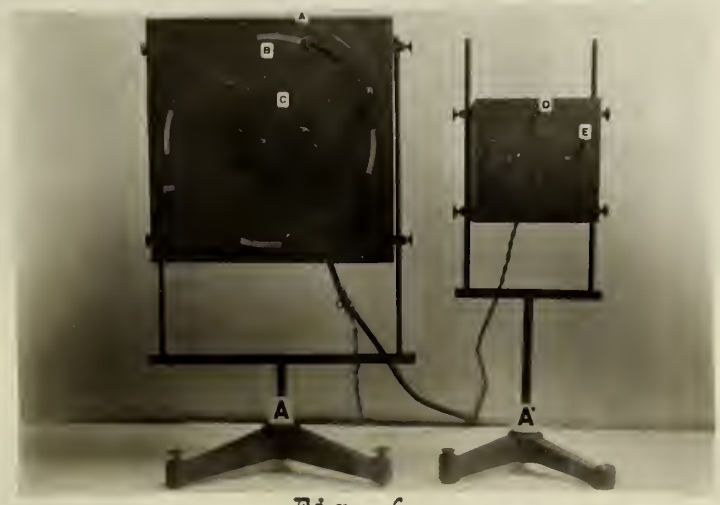


Fig. 6

[1] C.W.Perky(op.cit.,437) employed a method which was, in general, the same as ours. A luminous dot served as a fixation point. Four others were within the limits for the blind spot, and another point was just beyond the limit of the field of vision. The ocular move-

that any one of their openings coincided with an aperture in the box, and a point of light from the electric bulb inside became visible to the observer. We used a resistance box to reduce the current until the point of light lost its dispersion-halo, although the dots were still plainly visible. By adjusting the discs B, C, and E, and the slide D, points of light could be shown at distances of 5 mm. along the eight radii of the large box or along

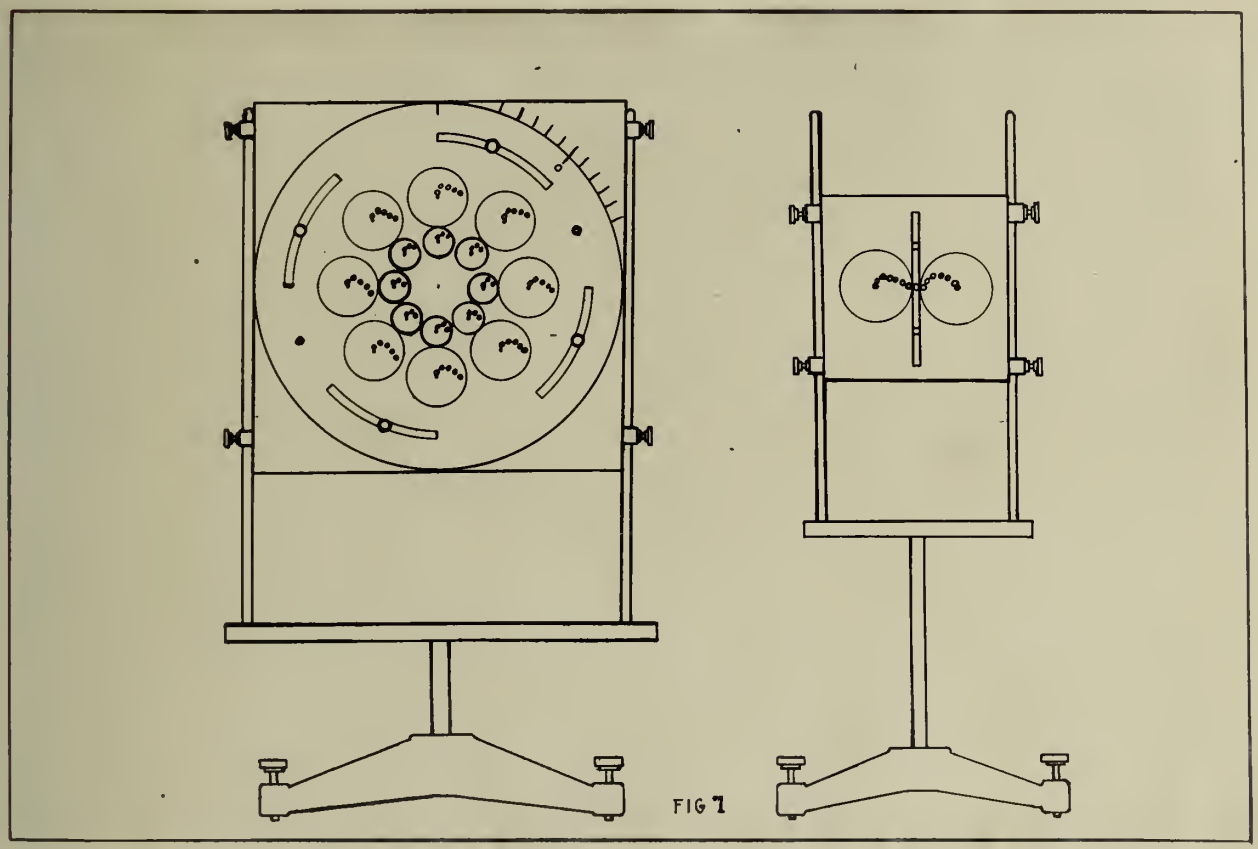


FIG 7

(Dimensions reduced 1/6)

(Cont. from p.26) ments which could be detected by this method were considerably larger than those which were discoverable by means of our apparatus.

either of the two intersecting lines of the small box. Both pieces of apparatus could be raised or lowered on their standards.

2. Method. C, D, and F served as observers. F was an instructor in psychology and had had wide experience with similar problems. O was seated in a chair with his head fixed in a head-rest and his right eye covered with a black cloth. His left eye was at a distance of 1½ meters from the small box, and the point of light at the intersection of the two lines of holes appeared opposite the fovea. This dot served as a fixation-point; the other openings were covered. Light was admitted through apertures successively nearer to the center of the disc A until those points were found which cast beams of light just within the area of the blind-spot. As a check upon the accuracy of the adjustment, the slide and the disc on the small box were so moved as to admit light through apertures 5 mm. above or below, and at the right or the left of the original fixation-point. When either of these four adjacent spots was fixated, some of the points of light on the large box became visible. An extremely slight change in the position of the retina of the eye brought the lights partially within the field of vision.

Before each experiment, the headrest and the boxes were adjusted with reference to O's blind-spot, since a different arrangement was necessary for each observer. When O had taken his place in the dark room, he was given the following instructions: "You will be shown a series of four drawings, the experimenter naming each one as it appears. Shortly after a 'ready' signal,

a drawing will be exposed for 20 seconds. After a further interval, of 20 seconds, another will be exposed, and so on." The drawings were placed over the fixation-point of the small box and were illuminated from above. During this part of the experiment, the apparatus was concealed by a black screen with an opening (2" x 1½") through which the card was visible. After the perceptual series, the observer was instructed as follows: "You are to fixate the single point of light. The experimenter will pronounce the names of the drawings, and you are to call up a visual image of each. Try to hold the image constant, but, if it disappears, make no effort to recall it. Press the key when the image appears and release and press it whenever the lights at the side become visible. Release the key and say 'now' when the image disappears. Then give complete introspections for the period of the image." A kymographic record was made showing the appearance and disappearance of the lights as indicated by O. The experimenter timed each image with a stop-watch. During the last half of the series, each record was made for a period of 20 seconds, and the observer was required to recall the image if it disappeared during that time. Several other records were made as controls with each observer. Under the controls, O was told to fixate the point of light until the experimenter gave a signal to stop at the end of 20 seconds. Under these conditions, no attempt was made to arouse imagery. After each experimental period O's introspections were transcribed from his dictation. When nec-

essary, the experimenter questioned him with respect to (1) the kinds of conscious processes integrated with the total visual image, (2) associative processes, (3) the clearness of the image, and (4) the accompanying affective tone. O was then asked to sketch the object as perceived and as imaged.

3. Results. Although the drawings did not serve the purpose for which they were primarily intended, the results were significant in other respects. We thought that there might be some marked difference between drawings intended to be meaningless and the meaningful diagrams. Most of the pictures devised for nonsense drawings, however, proved to be meaningful or were accompanied by meaningful associative processes. Only 7 of the 88 images had no meaning for the observer or signified simply "drawing-shown-a-few-minutes-ago." There was no appreciable correspondence between images of this sort and the presence or absence of ocular movement. The experiments did, however, corroborate the results of the investigations which were mentioned in Chapter II with respect to the size and the accompanying affective tone of the image.

We have already cited a possible objection to the observer's reproduction of the image by a drawing. Since kinaesthetic and tactual sensations were involved in such a depiction, it was possible that the results were not exact representations of the images. But even if allowances are made for constant errors, the total results, as shown in Table XII, seem significant.

Since the drawings were 1½ meters away, one should expect the observer's representations to be slightly smaller than the originals. There was, however, a noticeable tendency to ex-

Table XII

	Under-estimated by less than 1"	Correctly estimated	Over-estimated			
			less than 1"	1"-2"	3"-4"	4"-6"
Images	30	14	30	3	2	2
Perceptions	39	20	23			

aggeration. This tendency was more marked with respect to the drawings of images than in the cases representing perceptions. Furthermore, although C's reproductions of her images were very frequently larger than the drawings, she said that she thought she always drew them somewhat too small. Her images were, then, probably more exaggerated than her representations of them would indicate.

Although the drawings were not of a character calculated to arouse affective processes, the images were sometimes accompanied by intense pleasantness or unpleasantness. Table XIII summarizes the results. The instructions were so explicit and exacting that the attempt to follow them often involved such an intense affective tone that it was impossible to determine what affective elements attached to the image proper. Unpleasantness was frequantly connected with doubt regarding the instructions or difficulty in following them, unsatisfactory vagueness or instability of the image, interruptions during the experiment, and kinaesthetic or other organic sensations. When, on the other hand, the image was familiar, unusually clear and stable, and when O experienced

Table XIII

	Pleasant	Neutral	Unpleasant	Pleasant and unpleasant
C	13	9	6	1
D	17	5	7	1
F	13	4	6	6
TOTAL	43	18	19	8

a feeling of confidence or satisfaction and succeeded without difficulty in holding the image constant and following instructions, the affective tone was pleasant. In 7 cases, the pleasantness or unpleasantness was referable to associations rather than to the image itself. In 8 cases of pleasantly toned consciousness, none of the conditions already mentioned existed, and the affection could not be explained by the nature of the object. These results, like those mentioned in Chapter II, suggest that total-images, regarded just as conscious complexes, may be agreeable.

The correspondence between the amount of ocular movement, the sort of image, and the condition of attention is rather striking when one compares all the results obtained from the several observers. The number of images associated with ocular movements is shown in Table XIV, the frequency of these

Table XIV

	C		D		F	
	I	Co.	I	Co	I	Co
Ocular Movement	29	4	7	4	28	3
No ocular movement	0	0	23	1	1	0

movements with any image, in Table XV. (I stands for the period of the image; Co., for that of the control). Not only did D have fewer images accompanied by ocular movement than did C or F,

Table XV

NO OF IMAGES			Seconds per movement													
			2	3	4	5	6	7	8	9	10	11	13	15	20	Median
	D	I			1			2	1						3	
		Co												1	3	
	C	I	1	5	4	4	2	8	2		2				1	6
		Co			1	2										
	F	I	1		3	1	2	7	1	2	4	1	2		4	7.5
		Co						1			1					

but the number of movements with single images was apt to be less in the case of D. There was also a noticeable difference in the general character of the images of the three observers.

(1) The size of D's images, according to his drawings, varied but slightly from that of the diagrams, while both C's and F's images were exaggerated in approximately 68% of the cases.

(2) None of D's images were incomplete, but 11 of C's and 15 of F's lacked some or many details.

(3) Four of D's images, 8 of C's and 9 of F's revealed inaccuracies of detail.

(4) Three of C's images and 6 of F's were of objects other than the diagrams. Four times, in the case of F, these representations were incomplete. D was always able to arouse an image of the perceptual drawing.

(5) D's total-images never contain imaginal visual elements which were not represented in the corresponding perceptual objects. No processes from other sense-departments were intimately integrated with the images. Such integration occurred with 5 of C's images. Four times the added elements were visual, and once

they were kinaesthetic. In 14 instances, F's total-images were elaborations of the perceptual object. The added elements were visual in 3 cases, kinaesthetic in 8, tactual in 2, and organic in one.

(6) D always drew the same diagram as representing both the image and its corresponding percept. This was the case with only 11 of C's images and with none of F's.

In short, when the images closely resembled the perceptual objects, fixation was usually steady; when the images differed considerably from the corresponding perceptual modes, ocular movement often occurred.

Individual differences were noticeable, not only in the character of the image, but also in the state of attention.

(1) In the case of 22 of D's images, there were a few (from one to three) simple groups of associative processes, usually secondary (or verbal). Twelve of C's images and 19 of F's either lacked such processes or were accompanied by a great many. Attention was apt to fluctuate when associative processes were so numerous as to act as distractions or when the absence of these processes made the images uninteresting.

(2) Further differences existed with respect to the degree of clearness and its fluctuations. Over half of D's images were very clear and steady. Twenty of C's images were very clear, but 19 of them fluctuated. Moderate clearness was characteristic of 15 of F's images, and fluctuations occurred in 24 cases.

(3) D's attention was less frequently secondary than was C's or F's. D reported a conflict between groups of processes, or attention with effort, 6 times, C 11 times, and F in 9 cases.

Fixation was usually steady when an image was very clear and did not fluctuate, when it was accompanied by few associative processes, and when attention was without effort. Under other conditions ocular movement tended to occur.

The dissimilarities among the images of a single observer are associated with ocular movement in the same way as

are variations in all the images of different observers.

In the six cases in which D's attention was secondary, fixation was unsteady. During the course of 4 other images the eyes moved, although attention was without effort, but in all of these instances there were many associative processes or irrelevant ideas. The one image which was noticeably vaguer than any of the others was also accompanied by ocular movement. All of C's images were accompanied by movements of the eyes, but the one image with which there was only a single movement in 20 seconds was very clear and constant, and attention was without effort. One of F's images was accompanied by no ocular movement. Attention was without effort, and the image was clear and constant. With 4 of his other images, there was only one movement in 20 seconds. In all of these cases, attention was without effort. Two images were very clear, and the other 2 were moderately clear, while the images remained constant or fluctuated but slightly.

If we turn to the kymographic records of the control-experiments, we see that they are in accord with the results already mentioned. Ocular movement frequently occurred during the controls, and, when it did, the general conditions of consciousness closely resembled those which were characteristic of the images accompanied by ocular movement.

To sum up, we may say that there is usually no movement of the eyes with images which are fairly faithful representations of the corresponding perceptual objects; while ocular movement tends to occur with images which differ from the perceptual objects in size, and in completeness and accuracy of detail, and, in some cases, when processes from other sense departments are integrated with the images.

There is a possibility that these associations between ocular movement and the character of the image are reducible to connections between ocular movement and certain conditions of attention. The variation of the image from the perceptual mode might often be due to its vagueness. An attempt to recall or rectify absent or incorrect details might lead to fluctuations of clearness and attention with effort.

Fixation is apt to be steady when there are few associative processes (but not so many as to distract attention from the image and not so few as to allow attention to wander), when the image is clear and stable, and when attention is without effort. When these conditions do not exist, ocular movements tend to occur.

The results of Experiment 3 are in general accord with those of a preliminary series in which C alone served as observer. The apparatus was a rough wood and cardboard model like the metal boxes in all essential details. A series of words was used to arouse images. O was required to time the images with a stopwatch and to press a recording key whenever the points of light became visible. During the course of 15 of the images, a beam of light was thrown upon the cornea of O's eye as in Experiment 1. Unfortunately, the light had to be of such a low intensity that the experimenter's observations of ocular movement are not reliable. The experimental conditions, especially the presence of the beam of light, distracted the observer. For this reason, the value of the results might be questioned if they were not in agreement with those of the other series.

Records of 22 images were obtained. Two of these were U-images, 13 were G-images, 7 were F-images. Of the F-images, 6 had somatic reference, 5 had a recognized scenic background, and 3 had fairly many associations. Of the G-images, none had a scenic background, and 11 had few or no associations. Ocular movements were reported by the observer with 5 (71%) of the F-images and with 7 (54%) of the G-images.

As regards attention to the image, there was no ocular movement in the one case in which the image was very clear and constant, or with another image which showed a gradual decrease in clearness. Ocular movement occurred 1, 2, or 3 times in 5 of the 10 cases in which the image was vague but exhibited no appreciable shifts in clearness, and in 8 of the 10 cases in which there were marked fluctuations in the clearness of the image. There was evidently a degree of correspondence between the frequency of ocular movement and the kind of image, and a rather marked relation of ocular movement to attention.

Experiment 4

1. Problem and method. While Experiment 3 was in progress, it occurred to the writer that, in spite of the apparent accu-

racy of the apparatus, the observer might sometimes be unaware of the spots of light even when the eyes moved. If O's attention were focused upon the visual image, there was a possibility that the light might fall upon a sensitive portion of the retina without touching off a report. To test this hypothesis, we combined the methods of Experiments 2 and 3. With the left eye the observer fixated the single point of light as in the preceding investigation. The right eye was closed, and the tambour used in Experiment 2 was adjusted against the lid. In general, the procedure was the same as in Experiment 3, except that, instead of exposing the drawings in a perceptual series and later arousing the corresponding images, a number of words were used as in Experiment 2. C, D, and F again served as observers. As a preliminary control, before each record was made, the observer intentionally moved his eyes. In all of these cases the movement was recorded and the dots of light became visible. Each record was taken for a period of 20 seconds, as in the latter part of Experiment 3.

2. Results. Six records were made with D as observer, 5 with F, and 8 with C. In D's case, no ocular movement was detected by either method. The dots were never visible during the 20 seconds of fixation, and the record made by the pneumatic system showed no fluctuation. During the course of 4 of F's 5 images, dots became visible, but the other recording line did not waver. Very slight ocular movements evidently sufficed to bring the dots within the field of vision, but were not large

enough to affect the tambour. One of C's records indicated that the dots became visible 5 times while therewere no corresponding fluctuations in the other line. In the other 7 cases, ocular movement was indicated by both lines. There was a general conformity between the two records, although in some cases the record made by the pneumatic system indicated more fluctuations than the other line.

There are several possible explanations of these apparent inconsistencies. (1) C sometimes saw the points of light 8 or 10 times in 20 seconds. It is very likely that she did not react quickly enough to record all the changes. (2) A twitching of the right lid might have changed the one record, although the eyes themselves remained steady, so that no dots appeared. (3) Where the excursion of the eyes was fairly wide, a fluctuation in the pneumatic record might have occurred when the projection of the cornea crossed the bulge of the tambour, and again when the eye resumed its original position, although the dots were visible but once. While one record was being made, the electric current was accidentally reduced, and the points of light became much fainter. It was probably due to this fact that the dots were visible less often than in the previous periods.

The results of this experiment seem to indicate that the suggested hypothesis is incorrect. If O's eyes had moved without his noticing the points of light, the pneumatic record would have fluctuated, while the other was unaffected. But this was not the case. When movement was recorded by only one line, it was the record made by O that showed fluctuations. The pneumatic system seemed the less accurate of the two. When slight movements of the eyes occurred, the subject noticed the dots, but the tambour was apparently not affected, while larger movements were recorded by both systems.

From the results of Experiment 4 we infer that the

perception of the dots of light during the experimental period indicated actual movement of the eyes. The results of the short experiment preliminary to Experiment 3 revealed the same correspondence between F-images and G-images which was discovered in Experiment 1. Ocular movement usually occurred with the former images, but not with the latter. In Experiment 3, we found that the amount of resemblance among images and their corresponding perceptual objects seemed to be connected with ocular movement. As has already been suggested, this correspondence may probably be reduced to an association of ocular movements and certain conditions of attention. Both Experiment 3 and the preliminary experiment confirm the correspondence of ocular movements with the degree of clearness and fluctuations of attention which was the most significant discovery in Experiment 2. In Experiments 1 and 2, the arousal of a particular image was not required, and the experimental conditions did not seem to impose any tax upon the observers' ability to hold the attention steady. In Experiment 3, however, as a reult of the exacting instructions there occurred numerous cases of secondary attention.' There proved to be a correspondence between this sort of attention and ocular movements.

Were we to attempt an explanation of the correspondence which we have discovered between different sorts of image, attention, and ocular movement, we should turn naturally to the facts of perception. A series of special experiments would be necessary fully to substantiate a transfer of general motor attitude

or of ocular movement from perception to visual imagery. Our results suggest, however, that there are several possible likenesses among perceptions and images in respect to movements of the eyes.

(1) When an extended perceptual object close at hand has many details, we must, in order to gain an accurate impression of it, glance now at one portion, now at another. Similarly, one frequently discovers ocular movement and shifts of attention when an image is rich in detail or is accompanied by numerous associative processes (as was the case with many of the F-images and with some of the images of drawings in Experiment 3)

(2) When a perceptual object has very few details, we are apt to grasp its significance at a glance and then to turn our gaze and our attention to something else. A similar tendency was manifested, in our experiments, in the case of some uninterestingly simple images.

(3) In perception, when an object lacks cognitive clearness, our eyes are often focused first on one part, then on another, in order to gain a more definite impression. Such waverings of the glance were also characteristic of images.

(4) Under normal conditions, when we attend successively to different aspects of a perceptual object, our glance almost unvariably follows the direction of our attention. We have already given instances of the agreement between fluctuations of clearness and shifts of fixation in imagery.

(5) Finally, when two rival objects claim the per-

ceptual attention, the glance is apt to waver between them. Our results showed that secondary attention to imagery also involved ocular movements. All of these resemblances seem to point in the same direction. In the absence of contradictory evidence we may, then, reasonably suppose that the relations existing between the character of the object, attention, and ocular movements in perception are transferred to analogous cases of imagery. Such an hypothesis is in harmony with the current view of the physiological functions underlying perception and imagery. When an object formerly perceived is imaged there occurs, presumably, through central excitation, a reinstatement of the approximate physical conditions of perception. The image presents much the same color, shape, size, and details as does the perceptual object. There might easily be a similar reinstatement of muscular reactions. In fact, the recurrence with imagery of the movements of the eyes involved in perception is a more probable phenomenon than is the accurate repetition of the visual details of the perceived object, since ocular reactions which are alike (at least in their gross characteristics) occur with a large number of perceptions, while a comparatively small number of objects present a close resemblance in their visual aspects. That is to say, there may be more likelihood of the integration of generic muscular reactions in imagery than of the formation of generic visual images.

CHAPTER IV

Summary and Conclusion

The results upon which we base our conclusions were obtained from six trained observers, four of whom served in two or more of the four principal experiments. The ocular movement occurring in connection with visual images was recorded in the various investigations by three different methods. There was a general agreement in the results whenever two or more experiments involved the same problems. Although individual differences were sometimes conspicuous, they were of such a sort as to substantiate our conclusions, not to invalidate them.

There is some agreement between our results and those of other investigators. In fact, a closer correspondence could hardly be expected in view of the variations in the instructions and methods, and, especially, at the differences in the criteria used in classifying the images. The memorial images of both Ogden and Perky should probably be considered as a sub-class of our F-images. Perky's images of imagination we should have classed as G-images; Ogden's images of imagination, as U-images. We found that our G-images (Perky's imaginations) and our F-images (Ogden's imaginations) were usually unlike in most of their characteristics. It is not, then, strange that there should be considerable disagreement between Perky's and Ogden's results when these two classes are compared. It is probably that Koffka's general images would be G-images in our classification, while his particular images would include both our F and U

classes.

1. Five of the characteristics of images which we have examined were also considered in much the same way by Perky, Martin, and Ogden. The following summary gives a comparison of the results.

(1) There was a general agreement in respect to associative processes, which frequently accompanied the memorial images of Perky,[1] Martin,[2] and Ogden,[3] and were found with our F-images, and also with Ogden's images of imagination[3] and our corresponding U-images. With Perky's[4] and Martin's[2] images of imagination and with our corresponding G-images, these accompanying processes occurred less often.

(2) Three of the four investigations indicated similarities of clearness and of detail. The memorial images of Ogden[1] and of Martin,[2] and our corresponding F-images, were apt to be distinct, not "scrappy" and "filmy", as were Perky's[3]. Instead of being "substantial" and "complete", like Perky's images of imagination[3], our corresponding G-images often presented few and vague details. Ogden's images of imagination[1] and our U-images were comparatively detailed and clear.

(3) The results of Ogden[4] and of Martin[5] also agree with ours in failing to show any correspondence between the kind of image and the presence or absence of color. Perky

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(1) 1 Op. cit., p.451.
2 " " ., p.408,412.
3 " " ., p.405.
4 " " ., p.447.

(2),(3) 1 Op. cit., p.398.
2 " " ., p.401.
3 " " ., p.451.
4 " " ., p.396.
5 " " ., p.387.

gives no statistical summary, but describes the images of memory as "colorless etchings", and those of imagination as "oftentimes, on the contrary, very highly colored"[1]. Her statements are, however, somewhat contradictory, for she also states that the images of memory "retained their daylight character"[1], while those of imagination took the illumination of their surroundings[2]. This statement might be interpreted as meaning that it was the memories that were colored and the imaginations that had no color of their own.

(4) The results of Ogden's investigation and of our own do not agree with Perky's with respect to affective tone. Ogden[3] found no evidence of Perky's memorial "mood of recognition" or imaginative "mood of surprise"[1]. In our investigation, the images (especially in the F-class) were frequently pleasant, but an explicit feeling of familiarity was not always found with F-images, and a feeling of strangeness or surprise occurred with only a very few U-images.

(5) As regards stability, there is no correspondence of results. Perky's memorial images were described as "scrappy and fleeting", her images of imagination as stable[2]. Martin's images of memory were usually, though not always, more stable than those of imagination[3]. Ogden's images of memory

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(3) 1 Op. cit., p.447.
(4) 2 " " ., p.446.
3 " " ., p.398.

(4) 1 Op. cit., p.442.
(5) 2 " " ., p.447.
3 " " ., p.407, f.

were less stable than the images of imagination[1], but we must remember that his imaginations were probably different from Perky's similarly named images. Our investigation revealed no significant correspondence between the kind of image and its stability. Where a comparison is possible, the total results of Ogden and Martin agree, in general, with those of the writer, while all of these three investigations give evidence which is contradictory to that of Perky[1].

2. As regards ocular movements, our results agree with Perky's in that these movements usually occurred with her images of memory and with our larger class of F-images, and were not, as a rule, reported with her images of general reference or with our corresponding G-images.

3. Perky found that attention was wandering in memory (as with our F-images), but was very narrowly focused in imagination (as with our G-images)[2]. She does not, however, hint at any close connection of ocular movement with attention, while our experimental results seem to indicate that ocular movement in imagery was associated primarily with the conditions of attention, and only secondarily with certain kinds of images of which these variations of attention were characteristic.

4. In respect to the relations between imagery and

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[1] It is surprising that Titchener should make such didactic generalizations from the results of Perky's experiment as are found in his recent discussion of "the memory-image and the image of imagination". (A Text-book of Psychology, 1914, 416 ff.)

[2] Op. cit., p.449.

perception, Perky says, "we thus reach the general conclusion that the materials of imagination are closely akin to those of perception"[2]. We offer two criticisms of this statement: (1) There seems to be no reason why Perky should base a doctrine of imagination upon her results. It is doubtful whether the term image of imagination can be more properly applied to her images of imagination (our G-images) than to her images of memory. (2) Our results lead us to believe that the confusion arising between perceptions and images may be due to similarity of function, rather than to differences in elementary processes.[1] The present investigation suggests that the possible transfer of motor attitude, especially of ocular movement, from perception to imagery accounts, at least in some measure, for the similarity of images and perceptions.

In so far as it is permissable to base generalizations upon our experimental results, we feel justified in drawing the following conclusions:

1. If visual images are arbitrarily divided into three groups upon the basis of the presence or the absence of (1) specific reference and (2) familiarity of the object, certain other functional characteristics are found to be rather closely associated with a particular group or with groups of images.

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[1] Cf. M. Bentley, op. cit., p.21. "May not the close relation between peripherally and centrally excited sensations be explained by similarity of function? A book before me now and remembered from yesterday is one book, whether perceived or imaged. The perception and the image mean for me one and the same object..... The fact that experience demands a superposition of the two systems explains their apparent likeness and also the occasional confusion of perception and memory."

[2] Op. cit. 451.

Pure types, however, are comparatively rare, and intermediate forms are relatively numerous.

2. A correspondence is discoverable between kind of image and amount of ocular movement.

3. This correspondence is probably to be referred to certain conditions of attention which vary with the type or class of imagery.

4. Changes in the clearness of the image correspond, to an appreciable extent, to movements of the eyes.

5. Ocular movement is more likely to occur in secondary attention than in primary or derived primary attention.

6. Characteristic ocular movements, and possibly general motor attitudes, may be transferred from visual perceptions to analogous images.

VITA

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